Journal of Rural Social Sciences

Volume 26
Issue 1 *Volume 26, Issue 1*

Article 3

4-30-2011

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Journal of Rural Social Sciences, 26(1), 2011, pp. 32–61.

RESIDENTS' PERCEPTIONS OF COMMUNITY AND ENVIRONMENTAL IMPACTS FROM DEVELOPMENT OF NATURAL GAS IN THE MARCELLUS SHALE: A COMPARISON OF PENNSYLVANIA AND NEW YORK CASES*

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ABSTRACT

Communities experiencing rapid growth due to energy development ('boomtowns') have reported positive and negative impacts on community and individual well-being. The perceptions of impacts vary according to stage of energy development as well as experience with extractive industries. Development of the Marcellus Shale provides an opportunity to examine these impacts over time and across geographic and historical contexts. This paper describes case study research in Pennsylvania and New York to document preliminary impacts of development occurring there. Cases vary by level of development and previous extractive history. The study finds that, in areas with low population density, higher levels of development lead to a broader awareness of natural gas impacts, both positive and negative. Participants draw from the regional history of

*Funding for this research was provided by The Pennsylvania State University College of Agricultural Sciences Seed Grant program. The authors gratefully acknowledge the insights and suggestions made by the reviewers. Please direct correspondence to: Kathryn J. Brasier, The Pennsylvania State University, Department of Agricultural Economics and Rural Sociology, 105-B Armsby Building, University Park, PA 16802-5600. Email: kbrasier@psu.edu.

extraction to express environmental concern despite direct, local experience. Our findings suggest the need to track these perceptions during development, and as individuals and communities react and adapt to the impacts.

The Marcellus Shale is a geological deposit containing significant natural gas reserves deep beneath portions of five Northeastern states (Pennsylvania, New York, West Virginia, Ohio, and Maryland). The Marcellus Shale has been described as among the largest natural gas 'plays' in the world. Covering approximately 34 million acres, geoscientists estimate that the Marcellus Shale will yield nearly 500 trillion cubic feet of natural gas, enough to supply the United States for twenty years (Engelder 2009). Geoscientists documented the presence of natural gas in the Marcellus shale several decades ago, but until recently the industry lacked the technological capability to extract the gas economically. The combination of hydraulic fracturing, horizontal drilling and exploration of greater depths, and rising energy prices, have led to a rapid increase in the exploration and extraction of natural gas from unconventional sources including the Marcellus Shale.[1]

The first Marcellus well was drilled in Washington County (PA) in 2003, and began commercial production in 2005 (Harper 2008). Since 2003, more than thirty national and international oil and gas companies have established lease holds in the region. In Pennsylvania, 195 Marcellus wells were drilled in 2008; in 2009, this number increased to 768. In 2010, 1,386 wells were completed and 3,314 wells were permitted (PA Department of Environmental Protection 2010). Drilling activity has primarily occurred in Pennsylvania and West Virginia; New York State placed prohibitive restrictions on the permitting of horizontally-drilled shale formation wells that require hydro-fracturing methods in July 2008, pending the results of a statewide Supplemental Generic Environmental Impact Statement (SGEIS).[2]

The combination of state-level differences and varying developmental stages provide an opportunity to document and compare the impacts of the development over space (and differing ecologies, histories, and policy regimes) and across time

[1] The term 'conventional' refers to reserves of natural gas found most often in reservoirs or 'traps' often at relatively shallow depths. 'Unconventional' natural gas is found "in geologically complex, nonconventional reservoirs such as tight (low-permeability) sands, gas-bearing shales and coalbeds" (Kuuskraa 2010:26). Extracting natural gas from unconventional reserves requires technologies to stimulate the release of the gas, such as hydraulic fracturing.

[2] Under New York Governor's Executive Order Number 41 (signed December 13, 2010), these restrictions were extended until July 1, 2011. The Executive Order states that the final draft of the SGEIS will be released 'on or about' June 1, 2011, soon after which drilling permits could possibly be issued.

(and stages of development). Literature documenting the community and individual effects of rapid growth in energy development has emphasized the need for longitudinal and comparative approaches (Brown, Dorius, and Krannich 2005; Brown, Geertsen, and Krannich 1989; Smith, Krannich, and Hunter 2001) to help establish causality. This paper describes community-level impacts as reported by formal and informal leaders within four counties in the Marcellus Shale region and describes how factors such as level of development and previous extractive histories affect those perceptions.

BACKGROUND

Stages of Development in 'Boomtowns'

Extraction of natural resources (i.e., fossil fuels, minerals, forest products, etc.) is often subject to 'boom-bust' cycles of rapid growth and decline (Galston and Baehler 1995). These cycles are driven by demand, prices for and characteristics of the raw material, technological change, social organization of the extraction process, and local and global political forces (Bunker and Ciccantell 2005; Freudenburg and Frickel 1994). Similarly, communities dependent on natural resource extraction are susceptible to population and economic fluctuations throughout extractive cycles (Brown et al. 2005). Research on communities experiencing energy development in the intermountain West during the 1970s described rapid industrialization and growth of previously small, isolated, rural communities, dubbed 'boomtowns' (Albrecht 1978; Cortese and Jones 1977; Gilmore 1976; Gilmore and Duff 1975; Kohrs 1974; Lantz and McKeown 1979).

During times of rapid energy development, resident attitudes span four stages: *enthusiasm* in initial stages when residents express positive expectations; *uncertainty* as residents notice that expectations are not being met and unexpected changes occur (Lovejoy and Little 1979; Thompson and Blevins 1983); *panic* as residents realize the magnitude of unexpected impacts on their community; and finally, *adaptation* as the changes become viewed as permanent (Freudenburg 1981; Gilmore 1976). Longitudinal studies of boomtowns have delineated a boom-bust-recovery cycle for rapidly expanding communities. This cycle emphasizes how community satisfaction, attachment, and social integration of residents can decline before the peak of rapid growth (Brown et al. 2005; Brown et al. 1989). During the recovery stage, residents create new interpretations of their area and of energy development, and form new relationships to their communities (Brown et al. 2005). Studies reveal a sharp recovery among multiple indicators of residents' experiences

and views toward their community twenty-five years after an energy boom (Smith et al. 2001).

Economic, Social, and Infrastructural Impacts of Rapid Development in Boomtowns

The expectations and initial impacts that define attitudes in the early stages provide insights into the different changes local leaders and residents experience as development evolves. Key areas potentially affected by energy development include the local economy, social and physical infrastructure, the natural environment, and social relations within communities.

Economic benefits are often the main reason energy development is embraced by community members, particularly in communities with histories of economic decline. *Jobs and business activity* directly related to extraction increase, as do jobs and business activity in sectors that provide goods and services to the industry and the workers associated with development. This new or increased business activity may have limited benefit for local residents or communities. Long-term residents in rural communities often do not have the skills and training for the jobs available in the new industry. Training local workers can take a substantial amount of time, and assumes that training is available and workers want to receive training and work in this industry (Lovejoy and Little 1979). Many jobs generated from energy development focus on providing goods and services to workers (The Perryman Group 2008). These jobs often have less stability and offer fewer benefits. In addition, although businesses catering to industry can see a surge in profits, local businesses may compete with each other and the new extractive industry for skilled workers (e.g., mechanics, heavy equipment operators, truck drivers). This competition leads to a shortage of skilled workers and strains the ability of local businesses to provide commensurate wages and benefits.

Secondary impacts may occur when increased *tax revenue* is generated through extraction (e.g., severance taxes) or business taxes from industrial activity. Property tax revenues may increase if assessed values rise to reflect new construction and increased market values of property. Higher personal income tax revenues may benefit municipalities, school districts, and the state if local incomes increase (due to jobs or royalty/lease income) and if the local tax structure enables collection of such local taxes (Theodori 2009). Overall, research on economic impacts indicates that actual benefits are often smaller than initially anticipated, some sectors experience negative effects (Thompson and Blevins 1983), and variations in community conditions and extractive sectors make it difficult to predict economic impacts in certain areas (Jacquet 2009).

Additionally, increased government spending on social services and infrastructure to accommodate population growth may negate observed fiscal gains. *Physical infrastructure*—housing, roads, water supplies, sewer systems—and *community services* experience unprecedented strain during 'boom' periods. Rapid, unpredictable growth provides unique planning and fiscal challenges for local municipalities (Cortese and Jones 1977; Markussen 1978). In the Barnett Shale, Theodori (2009) found that eight of the top ten problems noted by residents in early stages of development were related to traffic and damage to roads, environmental quality, and land use.

Housing is another challenge in small, rural boomtowns with limited housing stocks. The rapid influx of industry workers quickly fills available rental units and temporary housing (such as hotels and mobile homes). New housing takes time to build, and communities are often reluctant to approve large-scale development projects that may not be needed following the 'boom' period. Housing shortages can result in rapid escalation of purchase prices and rental rates, pushing long-term residents out of the housing market (Gilmore and Duff 1975), exacerbating stress on these individuals and families.

Rapid growth in boomtowns is also linked with mixed *social impacts*. Early research on boomtowns emphasized negative impacts, leading to the development of the 'social disruption' model (Markussen 1978; Merrifield 1984; Park and Stokowski 2009).[3] This work demonstrated that rapid population growth associated with the development of industry can increase stress, change individuals' patterns of interactions within communities, decrease community cohesion, and change a community's character. Individuals' quality of life, ties to community members, and mental and physical health can also be affected, leading to increases in social problems (e.g., crime, substance abuse) and overall disorganization (Albrecht 1978; Cortese and Jones 1977; England and Albrecht 1984; Finsterbusch 1982; Freudenburg 1981; Freudenburg, Bacigalupi, and Landoll-Young 1982; Freudenburg and Jones 1991; Gilmore 1976; Gilmore and Duff 1975; Kohrs 1974; Krannich and Greider 1984; Lantz and McKeown 1979). This increases stress on local organizations and community services, and creates a lower standard of living for persons detached from the extractive-related economy. Social impacts are experienced differentially based on social class, gender, age, length of residence, and

[3] For debate of this model, see Albrecht 1982; Brown et al. 1989; Finsterbusch 1982; Freudenburg 1982; Gale 1982; Gold 1982; Krannich and Greider 1984; Murdock and Leistritz 1982; Thompson 1979; Wilkinson 1984; and Wilkinson et al. 1982.

degree of direct benefit from the development (Brookshire and D'Arge 1980; Forsyth, Luthra, and Bankston 2007; Freudenburg 1981, 1984, 1986; Hunter, Krannich, and Smith 2002; Seyfrit and Sadler-Hammer 1988).

The types of social disruption and individuals affected vary over the cycles of energy development. Long-term residents report the highest levels of *community satisfaction* through all phases (boom, bust, and recovery) of development (Brown et al. 2005). As development evolves, many community members and services can adapt (Albrecht 1978, 1982; Murdock and Leistritz 1979). Adaptations for some communities and community members have led to positive experiences related to economic effects through various phases of development (Brookshire and D'Arge 1980; Krannich 1981). Indicators of well-being, such as community satisfaction, trust in other community residents, and social ties, rebound to pre-boom levels after intense development subsides (Brown et al. 2005; Smith et al. 2001). Recent research suggests that economic growth resulting from energy development creates and bolsters social and economic cohesion, rather than weakening these ties (Brown et al. 2003).

Most boomtown research focuses on rural communities, though there are exceptions. Research on more urban communities has challenged the social disruption model. In Texas' Barnett Shale, located in and near Fort Worth, both positive and negative impacts of development have been reported (Anderson and Theodori 2009; Theodori 2009). In Louisiana, Forsyth et al. (2007) documented either positive or benign perceptions of offshore oil development, while Luthra et al. (2007) found no changes in crime during periods of offshore oil growth. The absence of social disruption in urban contexts is attributed to the ability of urban areas to absorb rapid population growth (Gramling and Brabant 1986). The migration patterns and residence characteristics specific to offshore oil development further demand consideration of the social disruption model's application to all forms of energy extraction (see also Little 1977; Luthra et al. 2007). The mixed results and empirical complexities noted in the social disruption literature indicate that, although the model's validity has not been confirmed for the present research, it does provide a useful starting point for examining impacts of energy development in the Marcellus Shale.

Application to the Marcellus Shale

*Applying th*e boomtown literature requires recognizing significant differences between the communities in previous research and the boomtowns developing in the Marcellus Shale region. Communities in the Northeast region have differing

histories, geography and topography, environmental conditions, economic bases, natural resources, and regulatory and municipal structures than those examined in the social disruption literature.

This paper has two purposes. The first is to document local leaders' perceptions of impacts of natural gas development in the Marcellus Shale region during early stages of development. This establishes a foundation from which subsequent research can examine change in these communities as they transition through developmental phases. The second, more analytic, purpose is to compare perceptions across stages of Marcellus Shale development and history of natural resource extraction. Our project examines four cases (counties) to describe and compare the perceptions of community leaders (Greider and Krannich 1985a, 1985b; Krannich, Greider, and Little 1985). These differential contexts define the types of actions possible, and provide a set of experiences from which community leaders can draw comparisons and expectations about development (Thompson and Blevins 1983). We expect that these early perceptions will establish pathways for action within communities, pathways that will likely influence the options available to them in the future.

CASE LOCATIONS

This study examines four cases in Pennsylvania and New York. We used purposeful sampling (Creswell 2005) to select two counties with higher levels of Marcellus Shale development (Washington County, PA and Bradford County, PA) and two counties with less or no current development (Lycoming County, PA and Steuben County, NY). Before the enactment of New York's effective moratorium, Steuben County had experienced significant leasing activity and the organization of landowner coalitions, but little drilling in the Marcellus Shale. Our case selection also considers variation in natural resource extraction histories. Bradford (high activity/low experience) and Lycoming (low activity/low experience) counties have little direct experience with fossil fuel development. By contrast, Washington County (high activity/high experience) has a long history of coal and shallow natural gas extraction. Similarly, Steuben County (low activity/high experience) has experienced conventional natural gas development. Washington and Bradford Counties are considered 'sweet spots' by the industry because of high early production levels (*E&P Focus* 2010). Table 1 shows the county classification.

Bradford County is located in northeastern Pennsylvania on the New York state border. The county is geographically large, with the smallest population (61,131 in 2009) and lowest population density (54.5 people per square mile in 2000) of our

TABLE 1. CASE STUDY SITES BY EXPERIENCE WITH FOSSIL FUEL EXTRACTION AND CURRENT LEVEL OF MARCELLUS SHALE ACTIVITY

	HIGH ACTIVITY	LOWER OR NO ACTIVITY
Prior experience.....	Washington	Steuben
Little or no experience.	Bradford	Lycoming

cases (see Table 2). The county population declined by 2.6 percent from 2000 to 2006-08. The top employers (more than 10 percent of employment) in Bradford County include educational services, healthcare and social assistance, manufacturing, and retail trade (see Table 2). In 2009, Bradford County was the third most active Pennsylvania county in terms of wells drilled (113 wells with a density of 9.7 per square mile) and first in wells permitted (430 or 37 per square mile) (see Table 3). This was the highest density of well permits among the case study counties and the second highest density of wells drilled (PA DEP 2010).

Lycoming County is located in north-central Pennsylvania and had 116,840 residents in 2009. The population declined by 2.7 percent from 2000 to 2006-08. Lycoming County contains the metropolitan statistical area of Williamsport. Lycoming County does not have a history of fossil-fuel development, but it was the center of a thriving lumber industry in the 1800s. Like Bradford County, the major industries (more than 10 percent of employment) include educational services, healthcare and social assistance, manufacturing, and retail trade (Table 2). Largely due to transportation networks and its central location, Williamsport has become an industry hub for energy companies and workers for the surrounding region. In 2009, the county was the ninth most active county in terms of wells drilled (24 for 1.9 per square mile) and sixth in wells permitted (107 for 8.6 per square mile) (PA DEP 2010).

Washington County is located in southwestern Pennsylvania, and is part of the Pittsburgh Metropolitan Statistical Area. It has the largest population of the cases, with 207,389 residents in 2009, as well as the highest population density (236.8 per square mile). Of the four cases, Washington County is the only county that experienced population growth (2.2 percent) from 2000 to 2006-08 (Table 2). Washington County has a long history with extractive industries (including natural gas, coal, and coal bed methane) that once fueled a vibrant steel industry. Like Bradford and Lycoming counties, industries employing more than 10 percent of residents included: educational services, healthcare and social assistance, manufacturing, and retail trade. However, the county's economy is somewhat more diverse, with lower employment in manufacturing and higher employment spread

TABLE 2. DEMOGRAPHIC AND ECONOMIC CHARACTERISTICS OF CASE STUDY COUNTIES

	BRADFORD	LYCOMING	STEUBEN	WASHINGTON
Total population (2009)[a]	61,131	116,840	96,552	207,389
Population change (2000-2009)[a]	-2.6%	-2.7%	-2.2%	2.2%
Population density (2000)[a]	54.5	97.2	70.9	236.8
Median household income (2008)[a]	$40,033	$42,005	$43,568	$50,791
Percentage of employed population by industry (2006-2008)[b]:				
Agriculture, forestry, fishing and hunting, and mining	4.8%	1.4%	3.0%	1.7%
Construction	6.0%	7.6%	7.2%	8.1%
Manufacturing	23.6%	19.8%	21.9%	12.0%
Wholesale and retail trade	13.5%	15.9%	13.5%	16.1%
Transportation, warehousing and utilities	5.5%	4.4%	3.3%	5.6%
Finance and insurance, and real estate and rental and leasing	4.1%	4.2%	3.6%	6.4%
Services	39.8%	41.8%	43.7%	46.8%
Public administration	2.5%	4.9%	3.6%	3.3%

NOTES: [a]Source: U.S. Census Bureau 2000, 2008, 2009; [b]Source: 2006-2008 American Community Survey 3-Year Estimates

TABLE 3. MARCELLUS SHALE ACTIVITY LEVELS

	BRADFORD	LYCOMING	STEUBEN	WASHINGTON
Well permits issued[a].....	430	107	**	239
Wells drilled (2009)[a].....	113	24	**	138
Well permits issued per sq. mile (2009)[a].....	37.0	8.6	**	24.3
Wells drilled per sq. mile (2009)[a].....	9.7	1.9	**	16.0

NOTES: [a]Source: PA Department of Environmental Protection; **No permits were approved for drilling in New York during 2009. Prior to the moratorium, 8 Marcellus wells were drilled in Steuben County (NY Department of Environmental Conservation 2010).

across multiple industry categories. Washington County was the site of Pennsylvania's first producing Marcellus Shale well. In 2009, the county was the most active Pennsylvania county in terms of Marcellus wells drilled (138 for 16 per square mile) and third in the state in wells permitted (209 for 24.3 per square mile) (PA DEP 2010). Washington County had the highest density of wells drilled among the four cases.

Steuben County is a geographically large county in south-central New York State, and had a population of 96,552 in 2009, a decline of 2.2 percent since 2000. The economic activity of Steuben County is similar to that of Bradford and Lycoming Counties, with most employment found in educational services, healthcare and social assistance, manufacturing, and retail trade industries (Table 2). Drilling and permitting of Marcellus wells were restricted in July 2008 pending review of New York's environmental regulations. Before the restrictions were enacted, eight Marcellus Shale wells were drilled in Steuben County and significant

leasing activity took place.[4] The restrictions have created an opening for significant organizing, particularly of landowner coalitions and anti-drilling groups.

METHODS

To identify key informants, we developed a list of organizations and institutions potentially affected by natural gas development in each county. This list included elected officials (township, county), local human and social service agency representatives, industry representatives, local business owners (directly and indirectly affected by development), landowners (including those representing landowner coalitions), environmental activists, and educators (Table 4). In each county, individuals within each category were identified based on publicly-available listings and discussions with county extension educators. For those categories in which public listings were not available or did not identify a person to contact, snowball sampling was used to identify individuals. Individuals were recruited through a combination of phone calls and emails using multiple contacts. A total of seventy-one key informants were interviewed in the four counties.

TABLE 4. NUMBER OF KEY INFORMANTS BY CATEGORY BY COUNTY

	BRADFORD	LYCOMING	STEUBEN	WASHINGTON
Business Owner.	1	2	1	1
Educator.	2	3	2	2
Elected Official.	2	2	4	4
Environmental Activist.	0	2	0	1
Industry Representative.	0	0	0	1
Landowner.	2	2	6	2
Local Agency Representative.	5	7	3	4
Total.	12	18	16	15

Individuals for all categories, in each county, could not be recruited. Natural gas industry representatives and environmental organizations were particularly

[4] During our study period, drilling activity to extract natural gas from the Trenton-Black River formation occurred at a few sites in Steuben County (NY Department of Environmental Conservation 2010). The Trenton-Black River is a deep geologic formation that contains pockets of natural gas. The most productive regions lie beneath western and southern New York State.

unresponsive or denied consent. Two industry representatives were initially contacted within each county, but only one (Washington County) participated. Directors of local and national environmental groups within each county were initially contacted. Of the eight groups contacted, only three participated (two in Lycoming County and one in Washington County). We speculate that the controversial nature of natural gas development in some areas, along with concerns about the proprietary nature of industry practices and techniques, diminished the industry representatives' interest in participating. Refusals to participate by environmental groups likely reflect a lack of organization and mobilization in the early stages of Marcellus Shale development.

We used semi-structured interviews to understand perceptions of impacts; evaluate these impacts as positive or negative; understand perceived future impacts; assess trust in industry and regulatory agencies; and ascertain position in the community relative to Marcellus Shale development. Key informants also were asked to describe the impacts of Marcellus Shale development they considered most important from the perspective of their specific areas of expertise. Interviews were conducted between August 2009 and January 2010, either in person or over the phone, to accommodate the schedules of respondents. Interviews ranged in length from 10 to 160 minutes with an average of 60 minutes. All interviews were audio-recorded and transcribed verbatim.

Each interview transcript was read by two members of the research team. Major themes were identified and a coding scheme was developed to organize the content of the transcripts. Each transcript was coded, and to ensure reliability, 20 percent of the interviews (10 interviews) were coded by two members of the research team (Tinsley and Weiss 1975). Inconsistent codes were discussed and reconciled. Data were managed using NVivo 8 qualitative analysis software.

The codes emphasized in this paper relate to the types of impacts reported by key informants. These codes include impacts on the local economy, aesthetic quality, agriculture, the environment, social relations and conflict, physical infrastructure, population change or diversity, community survival, and social services. Research team members then developed memos summarizing the impacts identified in each of these themes for each study location.

FINDINGS

The findings are organized into six themes: overall awareness; local economic impacts; social impacts; aesthetic quality, amenities, and environmental quality; agriculture; and physical infrastructure.

Overall Awareness of Marcellus Shale Activity and Perceived Impacts

Key informants across the study counties expressed different awareness levels of Marcellus Shale activity and perceived impacts. For example, several study participants in Washington County—the county with the highest level of activity, well density and population density—reported little awareness: "Well I think it has just sort of begun in this area. I mean I would not even be able to begin to speak exactly what has been drilling. I don't know if any Marcellus has been drilled here at all." In contrast, key informants in Bradford County (a highly active rural county), described a high awareness of activity: "You can't swing a dead cat in our county right now without hittin' a water truck." Another Bradford County key informant described many early impacts: "Revenue is generated. Potential jobs, you know…. People who were farming … now they may have a source of income that will allow them to maintain that way of life. I think that is a real positive, yeah. The impact on, you know, restaurants, small businesses I think is very good."

Key informants in Lycoming County, where there has been a relatively low level of activity, reported few changes overall. One key informant stated: "I don't see a major effect happening right now. There's not enough activity going on that I would say it's causing a major change in anything." Because of the statewide moratorium in New York, few changes in the local community were noted in Steuben County. Perceptions and experiences of respondents in Steuben County are less informed by direct experience with large-scale Marcellus Shale development than those in Pennsylvania, although many in Steuben County are carefully watching activities unfold in Pennsylvania.

Local Economic Impacts

Economic rejuvenation was largely perceived as the primary positive impact of development. Except for Washington County, the Marcellus cases had experienced economic decline for several decades, and the sheer magnitude of this industry attracted the attention of local leaders and residents. Key informants in all case studies identified four types of economic benefits: wealth creation, job creation, increased business activity, and tax revenue.

Wealth creation. Wealth creation occurs when local people receive lease payments and/or royalties from the production of natural gas from wells on their properties. The economic benefits, much like development, have occurred more quickly in Bradford County than in the other three counties. Respondents in Bradford, Lycoming, and Washington Counties described large bonuses for leasing mineral rights. One respondent in Washington County stated: "so far there have

been a lot of new millionaires in this area." During our field work, lease rates were reported up to $5,000 per acre plus 20 percent royalties in Bradford County (although some landowners reported signing for $5 per acre and Pennsylvania's state minimum of 12.5 percent royalty).

Job creation and business activity. Reports of job creation were mixed. Because of the specialized skills required, most of the direct industry jobs were filled by out-of-state crews. In all counties (even in New York where drilling was restricted), businesses directly serving the industry (e.g., construction) reported increased activity. The other major area of growth, and most visible to respondents in Bradford and Lycoming Counties, was the increase in service and retail industries, such as restaurants, bars, hotels, and fuel sales. Several key informants in these counties talked about the potential for multiplier effects that would support overall economic growth in the region, such as businesses selling household goods, cars, etc.

Price inflation and competition for workers were also reported in Bradford County. One key informant stated: "I have friends in the automobile dealership business. They are losing mechanics, because the gas companies are paying …a much more lucrative wage. . ." Rent, fuel, and food prices also rose as providers responded to increased demand. Lycoming County residents described the potential for inflation: ". . . the property values will go up because they end up costing more to live there. I think it's going to create inflation in the community." Unlike Bradford and Lycoming County respondents, participants from Washington County did not describe inflation now or in the future as an impact. This is despite the fact that Washington County has significant drilling activity.

Tax revenues. Currently, there are few local tax revenues from natural gas development in Pennsylvania, because natural gas is not subject to property tax, and leasing and royalty income are not subject to local earned income taxes. New York has an *ad valorem* tax[5] on gas production, but little gas production from the Marcellus Shale has occurred. Discussions in both Pennsylvania and New York have focused on the fairness of these taxes, the implications of taxing a growing industry, the implementation of a severance tax, and the potential recipients of tax revenues. Key informants in our case study counties unanimously agreed that a severance tax would be beneficial; however, there was significant debate about the

[5] Ad valorem taxes are taxes assessed and collected at the county and municipal level on the fair-market value of natural gas produced during the preceding calendar year.

fairness of a severance tax and the preferred distribution of revenues to different levels of government.

Despite the lack of a direct mechanism for collecting local tax revenue in Pennsylvania, key informants in all three counties described the gas industry's presence as a potential benefit to all community members, even those without leased property. According to them, overall economic activity would increase, and municipalities could generate revenue through increased business taxes and earned income tax revenues on resident wages. One respondent in Bradford County noted: "Even though they may not directly impact from it, they benefit from it. Because of taxes holding the line rather than going up." In relation to the severance tax, another respondent stated:

> "… if you're not a landowner and hold a lease or have a well on your property or work for a gas company or have a business that interfaces with a gas company, you think you may not be benefitting from this at all. … if there was a tax gleaned, like there is in oil and gas states, …then everybody in the community feels that they're benefitting from it …"

Generally, key informants were excited about the economic prospects incurred from developing the Marcellus Shale. Many believed the industry could drive their local economies well into the future. A Washington County respondent stated: "[Company] has put their Pennsylvania headquarters here. So that provides opportunities for skilled labor. Actually, white collar type jobs as well. It will change some of our youth." As manufacturing jobs leave rural Pennsylvania, the timber industry struggles, and dependence on agriculture declines, gas development could bring relatively long-term, sustained growth to Pennsylvania's rural economies. Respondents from all four counties believed the gas industry could diversify their local economies and prevent the out-migration of their youth.

Because New York has effectively—if temporarily—halted development of the Marcellus Shale, relatively few direct economic benefits were described by key informants. Those who had leased their land before the state's action had received lease payments but no royalties. Broader economic development, job creation, and multiplier effects were not reported. Some respondents in Steuben County spoke of the prospects of economic rejuvenation, based on watching Pennsylvania's experience: "You drive across the border to Pennsylvania and you look what it has done there. This will be no different…. All you see down there is new pick-up trucks and new tractors. I mean, the guy that sells that tractor, he is going to make

a bundle of money and the guy that sells the pickup truck and then he sells the gas." Most New York respondents expected the state to issue drilling permits in the future and they were excited about benefitting from the economic gains they perceived Pennsylvania residents were already receiving.

Social Impacts

Key informants in Bradford County reported population increases among gas workers and the potential for more in-migrants as economic activity increased. One participant reported a "population increase of about 1800 people in one month." Another commented that, by comparison, "Our biggest influx of people….is hunting season." The recent, rapid population increase concerned many respondents. Respondents in Lycoming and Washington Counties were concerned that the population growth might create increased demands on law enforcement, social services, schools, and emergency management, but did not describe actually observing these changes. Key informants in Bradford County, by contrast, described examples of recent stresses. The lack of housing created problems for social service agencies trying to place low-income and homeless residents in temporary housing. State police in Bradford County were citing more traffic violations, and the correctional facility had detained three out-of-state natural gas workers on misdemeanors—one had a warrant for a felony charge in Texas. Bradford County key informants also believed that, unless a severance tax was enacted and revenues distributed back to local governments, county and municipal taxes would have to increase to meet the rise in demand for social services.

The diversified mix of people who might migrate to the area concerned key informants in both Lycoming and Bradford counties. One respondent in Bradford County commented: "I hate to see this turn into a mini city….Will we see an influx of drugs and alcohol and gang stuff and that? Yes probably, but that comes with getting bigger." Many key informants worried that outsiders moving to rural Pennsylvania might not value "their way of life." A respondent in Lycoming County feared: ". . . a lot of the workers who are coming here from other places have no ownership and therefore they don't feel the need to take care of this area…. they don't care if they trash the place or spend all their money on booze or whatever." Key informants worried that cultural differences between long-term residents and newcomers would exacerbate existing schisms within the community, particularly between permanent and seasonal residents. Key informants in Bradford County spoke of the "wealthy folks" who could afford to refuse gas leases and keep the area pristine, or those who could lease their land but would not have to live with the

consequences of development: "… obviously they're not as concerned about the impacts as the people who live here full time…. If they're up here three weeks a year, or something like that, they don't have to worry about [it]." This concern was not raised in Washington or Steuben Counties.

Key informants in all four counties worried that Marcellus Shale development might lead to a "gap between the haves and the have-nots." Participants saw clear divisions between who would benefit and who would bear the burden of development. A Lycoming County respondent stated: "The haves I would certainly see would be large property owners, entrepreneurs, you know business owners that are already established. Those that are going to see income streams coming in from more and more people and more money circulating within the communities. [. . .] The have-nots could be certainly those that might not directly participate . . ." Those who are already economically disadvantaged or those who do not own sizable acres for leasing may only suffer the negative consequences of development. Several key informants noted that the gap between "the haves and have-nots" could be exacerbated by local businesses increasing their prices for necessities (e.g., housing, food, fuel) to take advantage of the industry's presence and the increase in their wealth.

Key informants also expressed concern about the potential for inequality and conflict among landowners receiving drastically different lease and royalty payments. A Washington County respondent commented: "There are many inequalities. Leasing is one. Those who signed leases early in the leasing phase signed for much lower amounts than those holding out, those with larger land holdings, and those participating in landowner groups." Many landowners interviewed—in New York and Pennsylvania—who signed in the early years believed the gas company took advantage of their naivete in the leasing process, fully aware that much higher bonuses and royalty amounts were possible in the future.

Bradford County key informants seemed particularly aware of the potential for polarization and conflict. They reported instances of neighbors fighting because one neighbor had leased land for financial gain while the owner of the adjoining property had to bear the negative effects of the drilling process. There have also been contentious public meetings related to the impacts of drilling. One respondent believed: "If it is private land and … you choose to let somebody drill on it, I think that is your decision to make. I don't think anybody else should try to make that decision but you. I know people around here are fighting. They don't want the land disturbed and they want Bradford County to stay like it is."

Key informants in Bradford and Lycoming Counties were concerned that rural communities such as theirs would bear the burden of development but urban centers would benefit from increased tax revenue. One Lycoming respondent commented:

> Of course the local communities are afraid that if this is taxed in a way that the state would want then too much of this money is going to go to benefit the larger cities. This money will head to Philadelphia and they would like to see a lot of this taxing money be local because it's our roads and bridges [that] have to be maintained.

These discussions suggest an underlying social division between rural and urban interests in Pennsylvania manifested in policy discussions such as the severance tax.

Aesthetic Quality, Amenities, and Environmental Quality

Many respondents in the four counties spoke of how their county was special to them and possessed a rural lifestyle they valued. Leaders in Lycoming, Bradford, and Steuben Counties spoke specifically of how their counties were wonderful places to reside, work, and raise a family. One respondent in Lycoming County commented: "[It's] such a beautiful place to live. I've turned down many opportunities to go other places and work for bigger pay, but it's such a beautiful … and a pleasant place to live that I hate to see those values be degraded." Uncertainty existed over how long the "temporary" negative aesthetic impacts of drilling activity would last. Some believed the worst would be over relatively soon (five to ten years), but others believed that there would be multiple waves of drilling that could continue for twenty to fifty years, or leave permanent scars. A respondent in Bradford commented: ". . . a lot of people very much value their rural quality of life here, the main reason why they live here…. if you had a list, that's top—above natural beauty and all that kind of stuff. So that's definitely something time will tell, if that gets diminished or not."

Perceptions of potential environmental threats were consistent across all counties, especially the impacts on water quantity and quality. Respondents were concerned that the water needed to drill and hydro-fracture horizontal gas wells could deplete surface water resources used for recreation and pose a threat to private wells and municipal drinking water sources. Many key informants reside in rural areas and depend on private water wells. One Bradford County key informant said: ". . . but the fact that there's millions of gallons of water being injected

underground at high pressure's gonna create some turbidity in some private wells…"

Similar to economic impacts, respondents in New York looked to Pennsylvania to identify likely environmental problems. Most Steuben County key informants indicated that with the proper environmental regulations and inspectors in the field, threats could be minimized. One Steuben County respondent stated,

> . . . it is almost like when DOT does a bridge or something they always have an inspector to make sure that the job is done right. So they need to have the state… inspectors to make sure these wells are done right so that it minimizes the risk of contaminating ground water, [and so they] know the different chemicals in the frac water… So those issues in my opinion need to be addressed and we need to go forward and let the companies come and drill.

Respondents were also concerned about surface and groundwater quality. Abandoned coal mine drainage and acidification of streams are issues throughout Pennsylvania, and participants in our four cases expressed a connection between the history of coal mining and Marcellus Shale development. Key informants expressed concerns that companies developing the Marcellus might leave similar environmental problems; they believed gas companies might deplete the forests, degrade the water, and then leave without taking responsibility for the cleanup, as has happened in the past. One Washington County respondent stated: "There was a spill of frac water five months ago or so. I don't think it was a major event. It caused a stir because there has been some suspicion in the environmental community that this is all bad. That these people are going to come in here and destroy the water ways and kill the fish and wildlife, etc." This concern follows incidents in Dimock and Damascus, Pennsylvania, where spills and improper well casings led Pennsylvania's Department of Environmental Protection to revoke drilling rights and permits for one natural gas operator.

Other threats discussed by key informants included damage to wildlife, deforestation, and air pollution. Key informants worried that loss of wildlife, forest resources, and air quality could significantly affect the local tourism industry. However, some respondents believed these environmental concerns would create business opportunities. One respondent from Lycoming County stated: "Williamsport Sewage Treatment plant is only taking like 80,000 gallons [of brine] a day. See that is all they can handle because it is hard to treat…So that is

something else that is going to be a big industry here. It is how to treat this brine water." Treatment plants for the frac water were mentioned as a means of increasing environmental quality locally, but also developing local businesses to cater to the needs of a growing industry.

Agriculture

Respondents in all four counties reported strong connections to the agrarian nature of their counties. Large landholders, many of them farmers, stand to benefit from lease and royalty income. While some believe that the financial stability will enable farmers to invest in their farms and continue farming, others expressed pessimism over agriculture and the agrarian future of their counties. Respondents asked: "are millionaires going to milk dairy cows?" One Bradford County respondent stated: "They are tired of dairy. They will just get out of the business. Retire. A lot of the dairy farmers are not kids anymore…" Therefore if farm land was no longer in production, many questioned: what would happen to the land? Key informants in Bradford County envisioned it "reverting back to scrub land," or potentially creating opportunities for the development of additional hunting camps. The concerns raised over large-scale landscape changes reflected the attachment many key informants expressed to the local landscapes and communities.

Physical Infrastructure

The final primary impact described by key informants in Bradford, Lycoming and Washington Counties was the toll of gas development on physical infrastructure. Key informants reported extensive damage to local roads; limited and increasingly expensive housing; limited storage capacity for trucks, equipment, pipe, and machinery; and significant construction related to gas pipelines, compressor stations, roads, and related infrastructure. Traffic and road damage were among the most discussed topics. To drill a well, companies often need to construct roads, requiring heavy equipment. Drilling and hydro-fracturing can require hundreds of truck loads per well, for equipment, pipes, water, sand, and chemicals, as well as wastewater. Although many municipalities and townships throughout Pennsylvania have posted and bonded their roads[6] or developed road maintenance agreements, gas companies operating in highly active counties have

[6] Posting means establishing weight limits for certain roads. Vehicles over the weight limit that need to travel the road must enter into an agreement with the municipality that usually requires establishment of a bond that secures payment for road damage.

damaged roads at a much faster pace than they have repaired them. Once repaired, many respondents agreed that gas companies restored the roads to equal or better condition than before they were damaged. One Washington County respondent said: "I also think that some of the rural, smaller communities … will have some of the nicest roads …in the state." However, where development progresses rapidly, residents must cope with damaged roads and road closures until crews can repair them.

Housing availability is strained in Bradford and Lycoming Counties. A Bradford County respondent stated: "for our homeless programs we would put people up at the local hotels and we wanted to put someone up two weeks ago and the next available room is [four months later]. So there is no short-term housing."As the housing stock becomes more limited, the rental rates and purchase prices for housing have drastically increased in Bradford County. These types of concerns were not articulated by Washington or Steuben County key informants, and only spoken of as potential concerns as development continues in Lycoming County.

SUMMARY AND DISCUSSION

This study explored the perceptions of key informants in four Marcellus Shale counties experiencing different levels of unconventional natural gas development and histories with natural resource extraction. At the time of this study, natural gas development was in the early 'boom' stages in Pennsylvania, while development in New York was suspended, pending environmental review. Respondents in the four counties outlined five principal areas of potential and current impact: the local economy; social relations; aesthetics, amenities, and environmental quality; agriculture; and physical infrastructure. However, the case study counties are experiencing these impacts at different levels. Here we compare and contrast – according to level of activity and previous extractive history—the key themes differentiating our case studies.

Level of Activity

Key informants in the two high-activity cases, Bradford and Washington Counties, identified only a few common impacts of development. Key informants in these two counties discussed perceptions of future impacts related to economic benefits, population increases, and roads. They were also concerned about potential changes to local quality of life and environmental quality. Beyond that, there were relatively few similarities between the current impacts discussed by respondents in these two high-activity counties. Although Washington County key informants

were concerned about the *potential* for stresses on social services, respondents in Bradford County reported that this change was already occurring. Key informants in Bradford County also reported many other current impacts, including inflation, housing shortages, and social inequality and conflict, not identified by Washington County key informants. Participants from the two counties with lower levels of activity, Lycoming and Steuben Counties, expressed similar levels of concern for environmental and rural quality of life threats. Lycoming County key informants are beginning to see economic impacts, population increases, inequality, and some road damage; they also recognize the potential for housing shortages and local price inflation. Steuben County respondents reported low-level effects from Marcellus Shale development, likely because of the moratorium.

The greater similarity between Bradford and Lycoming Counties (and particularly the dissimilarity between Bradford and Washington Counties) suggests that pre-existing community characteristics and experiences with extractive industries (rather than solely level of activity) are essential constructs for understanding how local, formal and informal, leaders perceive the impacts of extractive activity in their communities. Bradford County's small population, isolation from metropolitan areas, and lack of major transportation networks contributed to the county's lack of infrastructure and social services. The onset of Marcellus Shale development and associated population influx quickly overwhelmed existing facilities and services. In contrast, Washington County's proximity to a large metropolitan region (Pittsburgh, PA) and its developed social and physical infrastructure are likely why it has absorbed the influx of workers and the large scale gas industry. Although activity levels are high in Washington County, being part of the Pittsburgh Metropolitan Statistical Area makes the activity less visible and the impacts less discernable by key informants. The influence of population size, density, and relative isolation identified here echoes the findings of previous research (Gramling and Brabant 1986; Little 1977).

Extractive History

Extractive history seems to affect the perception of social and economic issues differently than perception of environmental issues. Key informants in Washington County—the case study with high activity and experience with fossil fuel development, including conventional natural gas—reported fewer types of impacts than did both counties without experience. One key factor was a key informant's comfort level with their knowledge of the industry and their access to industry officials. Washington County officials, even with the relatively high level of drilling

activity, believed they had more knowledge of the industry, whereas officials in the other Pennsylvania counties reported significant efforts to educate themselves about the industry and its potential impacts. Officials in Bradford and Lycoming Counties have taken several actions to address their inexperience with energy development. These actions included visiting other locations in the United States and Canada with similar types of extraction, maintaining ongoing dialogue with municipal and agency officials across Pennsylvania and the United States, and creating local task forces to continue educating themselves and the public on Marcellus Shale issues. In contrast, respondents in Washington County did not believe task forces or other similar efforts were necessary for obtaining information or fostering dialogue between the industry and county officials.

However, key informants in all four counties – regardless of extractive history – referred to the *region's* history of coal extraction and its legacy of environmental problems. They drew on this narrative to express concerns that the gas industry would not develop the Marcellus responsibly, but would instead extract the resource for profit and leave behind serious environmental problems for future generations to address.

A limitation of this research is the potential for confounding variables in the comparative design, especially (as noted) population size/density and related levels of infrastructure. Additional research is needed to clarify how levels of current activity, previous extractive history, and pre-existing community characteristics affect how development of energy resources is perceived to affect life in Marcellus Shale 'boomtowns.' Such research could utilize more cases that would allow analyses to disentangle these influences. The present research focused on the perceptions of local formal and informal leaders, and had limited participation of some groups, particularly environmental activists. Future research should examine the perceptions of a broader cross-section of the community to yield more diverse perspectives about the influence of Marcellus Shale development. We suggest that future research examine more explicitly the relative influence of proximity to population centers and the concentration of local populations near well-sites on perceived impacts of natural gas drilling, especially at the individual level.

A second confounding variable – state level policy – provides another fruitful avenue of research. This line of work could be especially interesting if and when the permitting restrictions in New York are lifted and development progresses. Proposed legislation in Pennsylvania related to the severance tax and a moratorium on leasing state-owned forest land for drilling would also change the context of Marcellus Shale development.

This paper's focus is on case differences, rather than on how development is experienced differentially by various residents within each community. Future research should address how perceptions of development vary based on community characteristics and an individual's place within the community relative to natural gas development.

Another issue implied in the key informant interviews is the stress placed on social and emergency services and housing by the influx of workers in the gas industry. At this time, little information is available on how energy companies decide where to locate their workers, where workers come from, the size of the geographic area these workers serve, and how long they stay in an area. Without this knowledge, it is difficult to accurately assess the relative demands these workers place upon local services, where these demands will occur, and for how long. Additional research on how communities can address the demands of a growing and diversifying population that includes transient workers may mitigate potential social disruptions.

CONCLUSION

The intent of this research was to develop a baseline understanding of how local formal and informal leaders currently experience and perceive future impacts of Marcellus Shale development. Additionally, this research began to parse out influences on the variability of those experiences. Previous 'boomtown' literature has suggested that level of development and extractive history may play an important role; however, our findings suggest that other factors also contribute to perceptions of current and future development. Population size, proximity to population centers and transportation networks, and level of infrastructure development interact with level of industry activity and extractive history to create variability in a key informant's perception of the impacts. The development of the Marcellus Shale, in a region of the United States with a mix of rural and urban areas, allows for further examination of these influences on communities' and residents' experiences. Subsequent work should document the experiences and community impacts during this development. The baseline research reported here provides a context in which future trajectories of development can be understood. Researchers and educators have a unique opportunity to further understand these processes as well as to assist communities as they manage perceived and actual social, economic, and environmental change.

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